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PACKAGING AND SHIPPING ANALYSIS OF THE C-5A DISPLACEMENT GYRO.(U)
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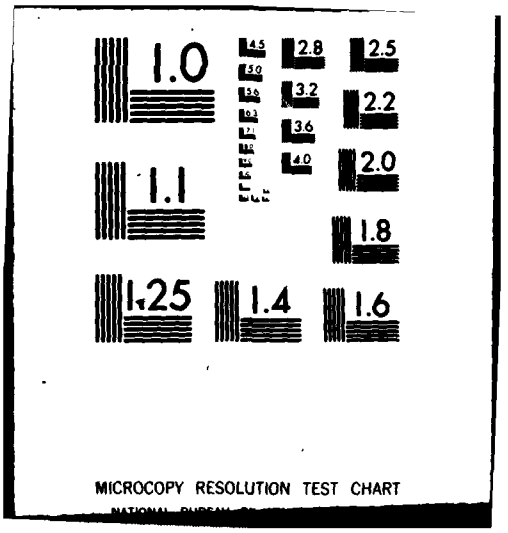
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MICROCOPY RESOLUTION TEST CHART

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LEVEL II

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PACKAGING AND SHIPPING ANALYSIS OF THE C-5A DISPLACEMENT GYRO

HQ AFALD/PTP
Air Force Packaging Evaluation Agency
Wright-Patterson AFB OH 45433

MARCH 1980

NOTICE

ABSTRACT

The C-5A Displacement Gyro has been consistently listed as a "High Burner" item on the K051.PW3-LQ-MQX aircraft maintenance cost data records and as of September 1979 it ranks number 49 on the list of 100 items. Evaluation of packaging for the gyro revealed that it can potentially be subjected to shock levels, during shipment, in excess of the 15 G fragility rating for this item.

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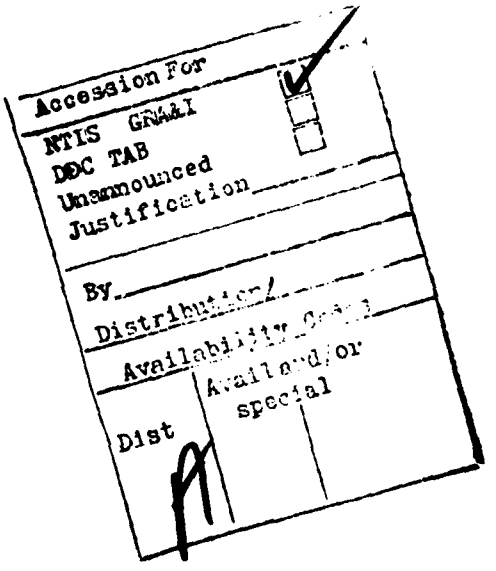


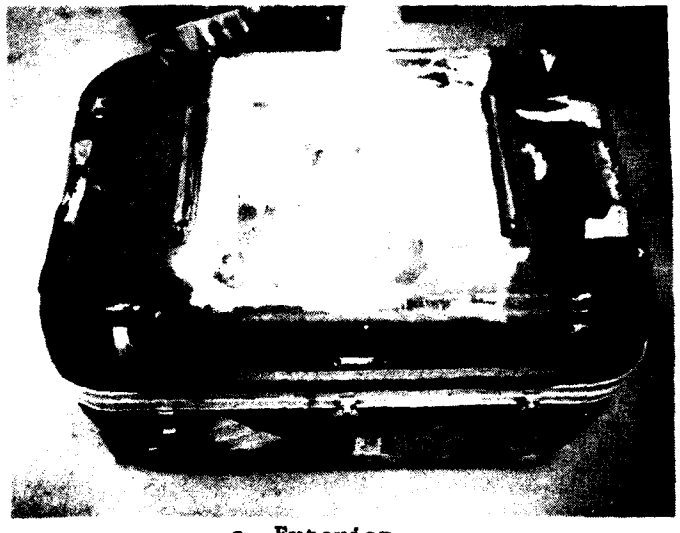
INTRODUCTION

The C-5A Displacement Gyro's reusable plastic pack (TPO 00-499-5940) was selected for a packaging evaluation because it ranked number 49 on the list of 100 high burner aircraft maintenance cost items (KO51.PW3-LQ-MQX).

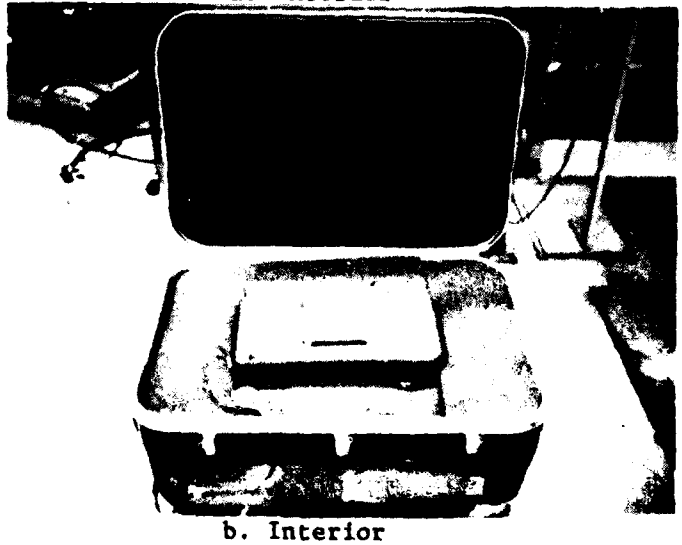
Since the attempt to obtain the items fragility rating was unsuccessful, it was assumed to be 15 Gs. Normally the gyros are the most fragile components in a guidance system and since the C-5A Inertial Measurement Unit (IMU) is rated at 15 Gs, this assumption is believed to be reasonable.

DESCRIPTION OF TEST PACK

The test pack was a rigid plastic reusable container which incorporated a 1 1/2 pcf polyurethane cushioning system (NSN 6615-01-006-8646LH). The inner plastic carrying case (NSN 6615-01-006-8647LH) includes a polyethylene cavity which prevents movement of the gyro. The gross weight of the test pack is 48 pounds and the outside dimensions are 30 x 22 x 20 inches (7.6 cube). The test pack is shown in the photographs of Figure 1.



a. Exterior



b. Interior

Figure 1. Test Pack

INSTRUMENTATION AND EQUIPMENT

The following instrumentation and equipment were employed for this evaluation:

1. Oscilloscope, Tektronic, 4 channel storage, Model 565B.
2. Accelerometer, tri-axial, Endevco, Model 2233E.
3. Amplifiers (3 ea), Endevco, Model 2424C.
4. Power Supply, Endevco, Model 2622C.
5. Transportation Environment Recorder, Bolt-Beranek and Newman, Model 714.
6. Recorder Readout, Bolt-Beranck and Newman, Inc., Model 615.
7. Drop Tester, Gaynes, Model 125.

TEST PROCEDURE AND RESULTS

The free fall drop test was conducted in accordance with Federal Test Method Standard 101B, Method 5007, Procedure B. Level A, 30-inch drop height. A tri-axial accelerometer was secured at the center of gravity of a 17½ pound simulated gyro test load. The test load is shown in Figure 2 and the test results are listed in Table I.

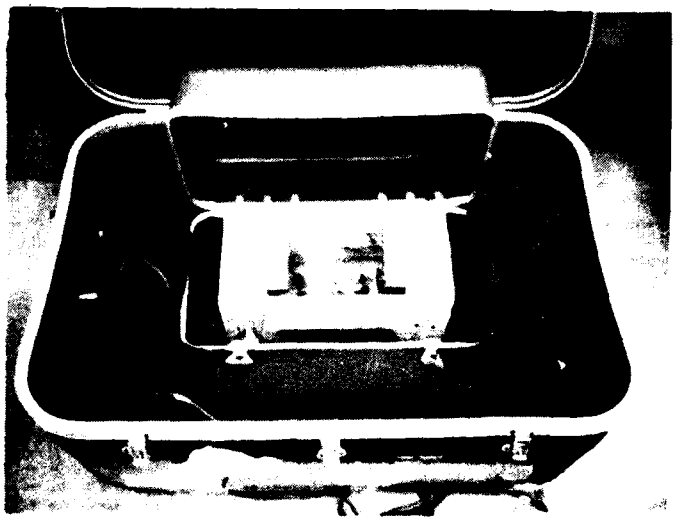
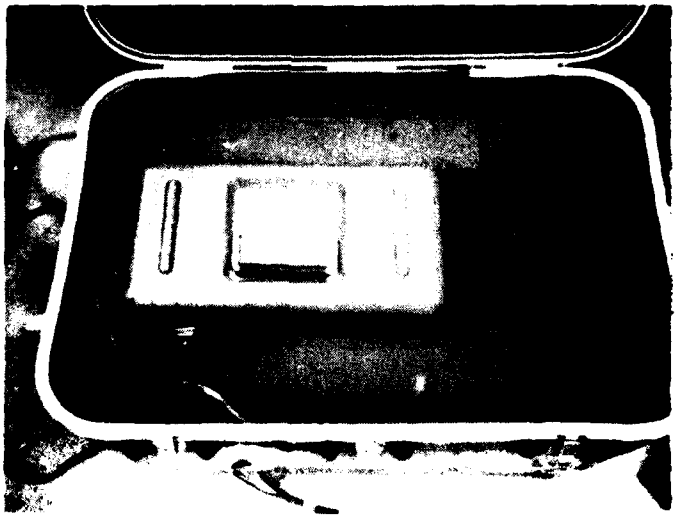


Figure 2. Test Load

IMPACT SURFACE	PEAK ACCELERATION - G				DURATION (ms)
	X	Y	Z	R	
3 (bottom)	3	6	21	22.0	50
1 (top)	2	3	22	22.3	60
2 (front)	0	19	1	19.0	50
4 (back)	0	13	1	13.0	55
5 (L. side)	10	4	3	11.2	55
6 (R. side)	8	1	4	9.0	75

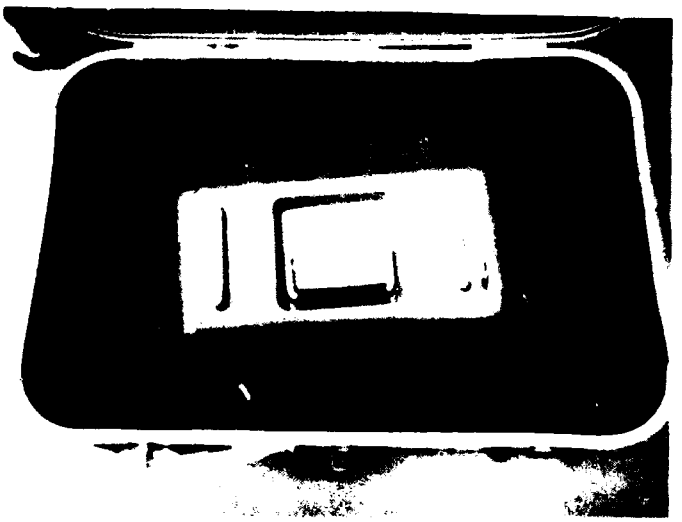
Table I. Drop Test Data

The visual inspection after this drop test series revealed that the cavity of the cushioning system was too small for the carrying case which caused a "grip effect" on the carrying case. This effect compressed the cushioning material which, in turn, reduced the effective cushioning characteristics of the material by one half. Figure 3 shows this effect. As a result of this effect a consecutive drop test seris was initiated and the results are presented in Table II. The test load was centered after each second drop.



a. Dropped on Left Side (face 5)

Figure 3. Effect of Undersize Cavity



b. Dropped on Front Surface (face 1)

Figure 3. Effect of Undersize Cavity

IMPACT SURFACE	PEAK ACCELERATION - G				DURATION (ms)
	X	Y	Z	R	
3 (bottom)	3	2	19	19.3	55
3 (bottom)	0	1	21	21.0	50
1 (top)	4	2	20	20.5	55
1 (top)	4	4	21	21.7	55
2 (front)	0	19	1	19.0	50
2 (front)	2	37	6	37.5	40
4 (back)	0	16	2	16.1	60
4 (back)	2	32	10	33.6	45
5 (L. end)	17	0	1	17.0	55
5 (L. end)	28	0	3	28.2	35
6 (R. end)	13	0	4	13.6	55
6 (R. end)	27	2	3	27.2	40

Table II. Consecutive Drop Test Data

A field test was conducted between Wright-Patterson Air Force Base, Ohio and Kelly Air Force Base, Texas, via Logair. The results of this test were recorded with a transportation environment recorder and are presented in Table III.

SHOCK LEVEL RANGE (G)	NUMBER OF SHOCKS RECORDED			
	X	Y	Z	R
2.5 to 5.0	7	9	46	78
5.0 to 7.5	1	0	4	10
7.5 to 10.0	1	0	3	2
10.0 to 12.5	0	0	1	1
12.5 to 15.0	0	0	0	2
TRIP DURATION: 14 DAYS				

TABLE III. Field Test Data

The low level shocks recorded during the field test is attributed to the large size of the container for its weight class. The location of the two handles makes it difficult to lift it to a height greater than 26 inches.

DISCUSSION

The laboratory test revealed that the item could potentially receive shock levels in excess of the 15 G protection level, a search was conducted to determine which cushioning material would provide the optimum protection. The total weight of the item and the carrying case is 22 pounds and the bearing areas are 143 in^2, 120 in^2, and 76 in^2. Military Handbook 304B and AFPEA's Computer Cushion Design Program revealed that the only material that would adequately protect the item to 15 Gs was 4 pcf polyurethane (ester).

CONCLUSIONS

The current cushioning system for the C-5A Displacement Gyro will not provide adequate shock protection for this item.

RECOMMENDATIONS

1. Replace the 1½ pcf polyurethane (ether) with 4 pcf polyurethane (ester).

2. Increase the cavity size of the polyurethane foam to prevent a "grip-effect" on the carrying case.

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